Tuning Environmental Parameters to Maximize Efficiency of Early Thermal Conditioning in Broilers

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ABSTRACT

This experiment aimed to test different combinations of temperature and duration of exposition to heat stress in young broilers, for a maximum efficiency of early thermal conditioning (TC) for application in practice. 162 male Cobb day-old chicks were submitted to one of three thermal conditioning treatments: 12 hour (T1) or 24 hours (T2) at 36-37,5ºC at 3 days of age, or control (CTR) at a constant temperature of 28ºC. Body temperature (BT) was considered as an indicator of TC success. It was recorded before and after acclimatization. Body weight (BW), food consumption (FC) and mortality (M) were recorded between 1 and 7 days. At day 5, there were significant differences (<.001) between the BT of treatments. Animals from T1 had the lowest BT (40.35°C), below T2 (40.71°C) and CTR (40.55ºC). The productive parameters showed significant differences between for BW and FC after TC, but these differences were NS in older animals. Liver and spleen weights were affected by TC treatment, but not heart and bursa. The TC during 3 days at 12 h was considered as more suitable for transfer technology to producers. TC should be improved in order to maintain the effect until the final stage of the production cycle.

Key words: thermal conditioning, broiler, thermal challenge, performance, thermotolerance

INTRODUCTION

In recent years the advances in genetic improvement of the broilers have increased performance but also made animals more vulnerable to adverse environmental conditions as high temperatures. In hot environments as tropical region or summer periods, this leads to reduced performance (chronic effect) and/or mortality (acute heat stress). Thermal conditioning (TC) at an early age has been proposed by various authors (Arjona et al., 1990; De Basilio et al., 2001) as a possible solution to reduce susceptibility of animals to heat. It consists of an exposure of animals at temperatures of 36 to 40°C during short periods in the first week of life. This management strategy reduces durably body temperature and induces thermotolerance against a possible heat peak at the final stage of rearing. Although various procedures have been proposed at the laboratory (Collin et al., 2007) the results are not always consistent form an experiment to the other. In order to transfer this technology to poultry producers, we planed to evaluate the combination of time and temperature of the TC to identify the best combination. The system used here is semi automated; easy and economical adaptation can be proposed in farms with lower technological advance.

MATERIALS AND METHODS

Birds and Management

The experiment was conducted at the Poultry Experimental Unit INIA, Aragua state, Venezuela. A total of 162 male Cobb day-old chicks were submitted to one of three treatments: control (CTR, constant 28°C) or thermal conditioning at 3d of age for 12h (T1) or 24h (T2) at 36-37.5°C. During the first seven days of life animals were raised in a room (5m x 11m) in an opened building, with three mesh fences circles 2.5 m in diameter, divided by half. In each half circle were placed six cages (40 x 38 x 15 cm) of six birds each. During TC, the room was divided into two areas (S1 and S2). S1 was kept at 28°C (by air conditioning) while in the S2 area ambient temperature was increased to 37.5 ° C and maintained at a range of 36 to 37.5 ° C during the acclimation of chickens. From day 7 to day 42 fences and cages were replaced by 32 pens of wire mesh of 0.5 mx 1.1 m, with rice hull bedding and kept at 28°C At day 42 the chickens were exposed to heat shock by increasing the temperature to 40 ° C for 8 hours using a gas brooder for 8 pens.

Measurements

Ambient temperature (Ta) and relative humidity (RH) were continuously recorded throughout the experiments using thermo-hygrometers placed at the chicken level. Body temperature (BT) was measured in the terminal colon with a thermometer Testo 110 and a immersion / penetration probe inserted into the cloaca. Body weight of chicks and feed and water intake was measured individually to the arrival of the chickens on days 4, 5, 6, 7 and weekly until the end of the test. On day 43, 8 birds per treatment were sacrificed for measurement of carcass parameters: weight of the carcass, liver, heart, gizzard, spleen and bursa of Fabricius.

Statistical Analysis

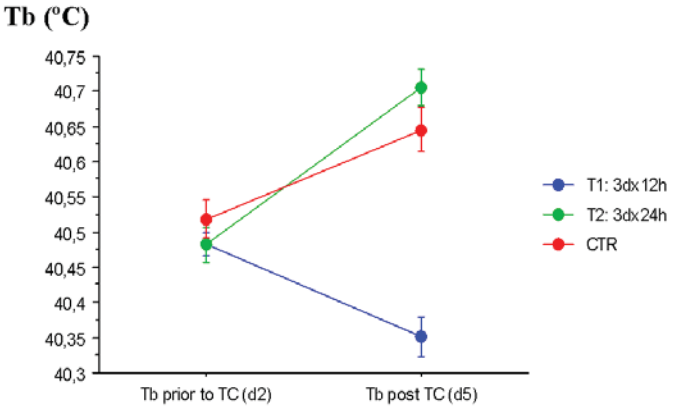
All results were subjected to standard statistical ANOVA and Fisher's PLSD, Post-hoc Test, using the Stat View package (Ver. 5.1, SAS corp., 1998).

RESULTS

Figure 1 shows the evolution of BT before (day 2) and after (day 5) thermal conditioning. BT was significantly reduced (-0.30°C, $p<0.0001$) but not in T2 (+0.0.6°C, $p>0.05$) compared to CTR. From day 7 to day 42, BT of all groups gradually increased. The animals from T1 treatment had constantly lower BT than the other groups (although NS), except at day 14 were it was punctually higher, possibly due to an artifact (health problem ?). In contrast BT of animals from T2 treatment showed an inverse behavior as T1 with no BT reduction after TC and even values above (although NS) CTR treatment.

Heat challenge occurred in day 42. The day after (Day 43, BT of all groups were lower than before heat challenge. The reduction was higher in CTR group (-0.27°C vs -0.10°C for thermal conditioned animals), although this difference was not significant due to high individual variations.

Figure 1 Body temperature of chicks before / after thermal conditioning



Performance parameters recorded before and after TC are shown in Table 1. There were significant differences at day 5 of age for body weight, weight gain, and feed consumption but not for feed efficiency. These differences indicated better performance of T1 animals compared to T2 and CTR ($p<0.001$). During the 14-42d period, no significant differences were observed for any of the treatments, although CTR tending to have lower growth performance and higher feed intake (but NS).

Table 1 Performance parameters of broiler chickens before and after thermal conditioning (1-5 days old) and during the finishing period (14-42 days old)

Parameter / treatment	TC 3d x12 h	TC 3d x 24 h	Control
Body weight (g)			
1 d	46.0 ± 0.37	46.0 ± 0.37	43.3 ± 0.81
5 d	143. 3 ± 1.66 **(a)**	134. 9 ± 1.49 **(b)**	134.0 ± 2.31 **(b)**
42 d	3 086 ± 47.0	3 086 ± 47.0	3 041 ± 56.6
Weight gain (g)			
1-5 d	72.0 ± 1.43 **(a)**	64.7 ± 0.93 **(b)**	63.02 ± 2.64 **(b)**
14-42 d	2.599 ± 39.8	2.607 ± 45.2	2.552 ± 58.7
Feed intake (g)			
1-5 d	64.8 ± 3. 08 **(a)**	58.2 ± 0.39 **(b)**	55.8 ± 2.42 **(b)**
14-42 d	4 142 ± 113.2	4 105 ± 83.6	4 294 ±113.2
Feed efficiency			
1-5 d	0.91± 0.06	0.90 ± 0.01	0.89± 0.03
14-42 d	1.59 ± 0.40	1.58 ± 0.41	1.64 ± 0.51

[a,b] Within rows, values with different superscript letters differ significantly ($P < 0.0001$).

Table 2 presents the results of organ weights; significant differences were observed in liver and spleen for T1 and T2, while the heart and bursa of Fabricius showed no significant variations.

Table 2 Means and standard error of% of weights of organs of broilers under heat conditioning early and sacrificed at 43 days old

Treatments	Liver	heart	spleen	Bursa
TC 3d x12 h	1,49 ± 0,098 **(a)**	0,41 ± 0,046	0,145 ± 0,01 **(c)**	0,153 ± 0,027
TC 3d x24 h	1,93 ± 0,144 **(b)**	0,46 ± 0,057	0,096 ± 0,01 **(a)**	0,148 ± 0,028
Control	1,88 ± 0,144 **(b)**	0,39 ± 0,022	0,126 ± 0,02 **(b)**	0,156 ± 0,026

[a,b] Within columns, values with different superscript letters differ significantly ($P < 0.0001$).

DISCUSSION

The results obtained during the first week showed that T1 treatment significantly reduced BT, the same way as reported by Yahav and McMurtry, 2001. This difference persisted at 42 days of age, although no longer significant after 14d. The success of TC depends on conditions since it was apparently not achieved in T2. It coincides with the results obtained by De Basilio et al., 2002, which even made the BT measurements by telemetry to rule out variations due to handling. It is shown once again that the physiological mechanisms of birds, which are not yet clear, are activated by environmental conditions, especially temperature and relative humidity and is manifested in changes in BT or not that can induce thermotolerance to severe heat stress conditions. The effectiveness of these thermal conditioning varies depending on the duration and intensity of the TA applied so that the selection of the optimum condition will depend on the scientific or productive objective.

The production parameters were not affected by TC treatments during TC or in the next step, which contrast with observations reported by b some authors (e.g. Yahav and Hurwitz, 1996), who reported reduced weight gain after TC and a compensatory growth 7-42d.

Rosa et al., 2007, found a direct effect of temperature on carcass and viscera yields, and decreased yields of the heart, liver and gizzard. Stress also causes a hormonal response that affect the immune response and that is reflected in the reduction of lymphoid organ weights, spleen, thymus and Bursa. (Perozo et al., 2004) The liver weights recorded correspond to standard average values for these types of birds. Liver weight was lower in T1 animals, which suggests that there was a greater efficiency of this treatment. It was not the case in T2, which confirms the lower efficiency of this treatment, already seen on BT.

From a practical standpoint, the results of this study suggest that TC during 12h at 3 days of age at a TA 36- 37.5ºC have a real effect, and is significantly more efficient that a longer period. This technology could be used in small scale production conditions.

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REFERENCES

ARJONA A. A., DENBOW D.M. and WEAVER, W. D. Jr. (1988) Effect of heat stress early in life on mortality of broilers exposed to high environmental temperatures just prior to marketing. *Poultry Science* **67**:226–231.

COLLIN A., BERRI C., TESSERAUD S., REQUENA RODON F. E., et al. (2007) Effects of Thermal Manipulation During Early and Late Embryogenesis on Thermotolerance and Breast Muscle Characteristics in Broiler Chickens. *Poultry Science* **86**:795-800

De BASILIO V., VILARINO M., YAHAV S. and PICARD M. (2001) Early-age thermal conditioning and a dual feeding program for male broilers challenged by heat stress, *Poultry Science* **80**: 29–36.

De BASILIO V., REQUENA F., LEON A., VILARINO M. And PICARD M. (2003). Early-age thermal conditioning immediately reduces body temperature of broiler chicks under a tropical environment, *Poultry Science* **82**:1235-1242

PEROZO F., MARIN J.N., MARAVEZ Y., ARENAS E., SERJE P. and BRICENO M. (2004) Morphometric Characterization of Ross Line Broiler Chickens Lymphoid Organs Reared Under Field Conditions in Zulia State. *Revista Científica FCV* **XIV(3)**:217-225,

ROSA PS, FARIA F, DAHLKE F, VIEIRA B, MACARI M. and FURLAN RL (2007) Performance and Carcass Characteristics of Broiler Chickens with Different Growth Potential and Submitted to Heat Stress. *Brazilian Journal of Poultry Science* **9(3)**:181-186.

YAHAV S. and HURWITZ S. (1996) Induction of thermo tolerance in male broiler chickens by temperature conditioning at an early age, *Poultry Science* **75**:402–406

YAHAV S. and McMURTRY J. (2001) Thermotolerance acquisition in broiler chickens by temperature conditioning early in life – the effect of timing and ambient temperature *Poultry Science* **80**:1662–1666.